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Morphological Study of Clavicle in Human Cadaveric Dried Specimens

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ABSTRACT

Introduction: morphology of clavicle is essential in understanding and designing fixative devices for displaced fractures of clavicle as well as for radiologists and physicians as variations in costoclavicular ligament bears resemblance with some pathological conditions. The aim of this study was to observe the clavicular morphology in relation to rhomboid impression and to examine the cross sectional profile at various points on the clavicle.

Material and Methods: the present study utilized 80 human dried adult clavicles and the patterns of costo-clavicular ligament attachment were studied. The topographical distance between the medial ends of clavicle and attachment of costo-clavicular ligament was determined. The cross sectional morphology of clavicle was studied at the shaft, medial and lateral ends.

Results: the cross sectional morphology showed a transition from quadrilateral shape on medial side to transversely flat on lateral side. The average topographical distance between the medial most part of clavicle and the costo-clavicular ligament was 8.33 mm. The most frequent pattern of rhomboid impression was rough and elevated, which is observed in 28.75% of cases.

Conclusion: the data collected from the present study will help the medical fraternity in reporting of fractures and to plan for adequate fixative devices.

Keywords: Clavicle; Costoclavicular ligament; Rhomboid impression.

Introduction

The medial 2/3 part of the shaft of clavicle on the inferior surface, presents the impression for the attachment to costo-clavicular ligament[1]. The costoclavicular ligament is truncated cone shaped, which is flattened antero-posteriorly with separate anterior and posterior laminae with a bursa intervening[2]. It acts as an important landmark during the resection of medial part of clavicle, which is performed for the sternoclavicular instability[3]. The attachments of rhomboid ligament produce tubercles, roughened impression, fossae, which can be misinterpreted as pathological[4]. Rhomboid impression has been used in anthropology as criteria for age and sex estimation[5,6]. The subclavian vein is present just behind the costo-clavicular ligament, thus this anatomical relation becomes crucial, while placing venous catheters and pacemakers[7-9]. Increased recognition of complications like nonunion, associated with clavicular fractures has increased the interest in surgical fixation of these fractures. The insufficient stabilization can lead to non-union, which is a painful condition and requires surgical procedure like Ilizarov's technique[10] or internal fixation[11]. The knowledge about the suitable area on the clavicular shaft for placing fixative device is mandatory for designing of a fixative device. This study aims to correlate the morphology of clavicle in relation to the rhomboid impression. The objectives were to observe the cross sectional profile of the clavicle at various locations over the shaft of clavicle and to bring out normal variants of clavicle, which are clinically important.

Material and Methods

This anatomical investigation utilized 80 adult human dried clavicles. Among them 40 each belonged to left and right sides. The gender and exact age of the specimens were not known. Only the intact bones were used for the study. The bones showing fractures, any visible deformities, obliterated landmarks were excluded from the study. The attachment of rhomboid ligament to the clavicle was observed by direct inspection. The various patterns were analyzed and classified as described by Cave[2] into:

Type IA: Flat and Rough
Type IB: Flat and Smooth
Type IIA: Elevated and Rough
Type IIB: Elevated and Smooth
Type IIIA: Depressed and Rough
Type IIIB: Depressed and Smooth

The distance between the medial most point of costo-clavicular ligament and the medial end of clavicle

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(Fig. 1) was measured by using the Vernier Caliper of accuracy 0.01mm. To study the cross sectional morphology, the clavicle was divided into three distinct zones. The points for demarcating into zones were selected by dividing the clavicle traditionally into 'one- thirds'. Since such a method is more used in clinical setting for fracture configuration, the above method of demarcating the zones was used. The total length of clavicle was measured by using the Vernier caliper with accuracy of 0.01mm. The shaft of clavicle was divided into medial, middle and lateral one thirds based on the length and position of the subclavian groove. The following points were used in the division of clavicle into zone1, zone 2 and zone 3 (Fig. 2).

Figure 1. Inferior surface of right clavicle; 1-impression of rhomboid ligament; 2-distance between medial end of clavicle to medial most point of rhomboid ligament.

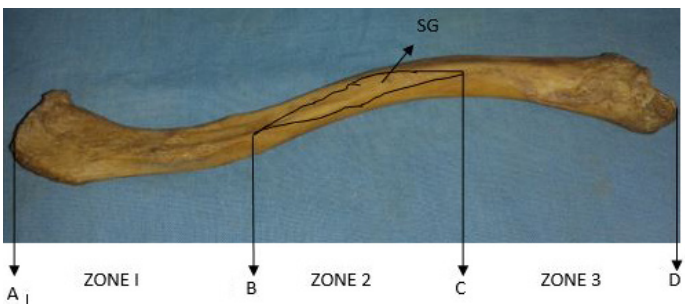

Figure 2. Inferior surface of right clavicle showing the division of zones, to study the cross sectional profile (SG-subclavian groove; A-sternal end of clavicle; B-junction between the medial and middle thirds of clavicle; C-junction between the middle and lateral thirds of clavicle; D-acromial end of clavicle).

Point A: medial end of clavicle

Point B: junction between the medial 1/3 and middle 1/3 of the clavicle

Point C: junction between the middle 1/3 and lateral 1/3 of the clavicle

Point D: lateral end of clavicle

Zone 1: part of clavicle between points A and B

Zone 2: part of clavicle between points B and C

Zone 3: part of clavicle between points C and D

The cross sectional profile was assessed at midpoint of each zone by direct visual inspection and recorded. The statistical analysis was done by using the recent online version of the SPSS.

A-flat and rough (type IA); B-flat and smooth (type IB); C-elevated and rough (type IIA); D-depressed and rough (type IIIA).

Results

Various patterns (Fig. 3) and types of attachment of the rhomboid ligament to the clavicle are shown in tables 1 and 2. It was observed that rhomboid impression was present in all the eighty clavicles (100%) taken up in the study. The bony impression for the costo-clavicular ligament attachment to the clavicle was mostly flat (Figs. 3A and 3B, 40%) followed by an elevated pattern (Fig. 3C, 32.5%). Depression or pit type (Fig. 3D) of the rhomboid impression was found to be the least, present in 27.5% of specimens. The Type IIA (Fig. 3C)- elevated and rough (32.5%) were common over the left and right sides. The area of attachment of rhomboid ligament was found to be rough in 82.5% of cases and smooth in only 17.5% of cases.

Figure 3. Patterns of impression of rhomboid ligament on clavicle; A-flat and rough (type IA); B-flat and smooth (type IB); C-elevated and rough (type IIA); D-depressed and rough (type IIIA).

Table 1. Patterns of attachment of rhomboid ligament to the clavicle

Nº of clavicles	Rough	Smooth	Flat	Elevated	Depressed
right side	36	4	15	13	12
Left side	30	10	17	13	10
Total	66	14	32	26	22

Table 2. Types of rhomboid impression on the clavicle.

Rhomboid impression (type)	Right clavicle (n=40)	Left clavicle (n=40)	Total (n=80)
IA: Flat and Rough	11	7	18 (22.5%)
IB: Flat and smooth	4	10	14(17.5%)
IIA: Elevated and Rough	13	13	26(32.5%)
IIB: Elevated and Smooth	-	-	0 (0%)
IIIA: Depressed and Rough	12	10	22(27.5%)
IIIB: Depressed and Smooth	-	-	0 (0%)

The distance between the medial end of clavicle to the medial most point of attachment of costo-clavicular ligament was ranging between the 2mm and 17 mm and the average was 8.33mm. It is advisable that, resection of 8mm at the medial end of clavicle can cause lesser damage to the costo-clavicular ligament and avoids the iatrogenic costoclavicular instability.

Various cross sectional profile obtained at the different points over the clavicle are represented in Fig. 4. The sternal end of clavicle was quadrangular in shape either in the longitudinal or transverse plane. The zone 1 was almost tubular, with shape varying as quadrangular or triangular or oval longitudinally. Zone 2 was mostly circular or oval, transversely in morphology. The zone 3 was more flattened with longest diameter in antero-posterior plane. The shape 7 or shape 8 (Fig. 4) was more common in zone 3. The table 3 shows the distribution of various cross sectional profiles at the ends and zones on the shaft of the clavicle.

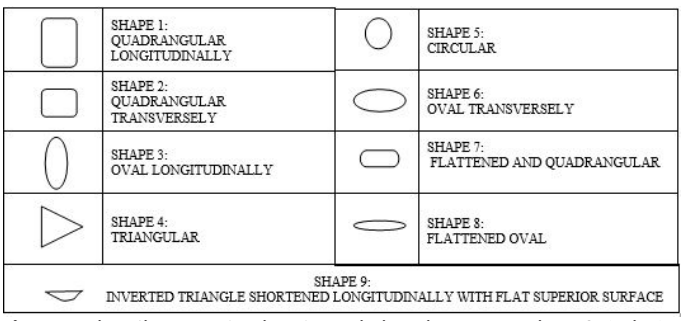

Figure 4. Line diagrams showing the variations in cross section of clavicular morphology.

Table 3. Cross sectional morphology of sternal end, acromial end and shaft of clavicle.

Cross sectional profile (shape)	Sternal end	Zone 1	Zone 2	Zone 3	Acromial end
1	69	6	-	-	-
2	11	-	-	-	-
3	-	38	9	-	-
4	-	36	12	-	-
5	-	-	51	-	-
6	-	-	7	-	-
7	-	-	-	8	-
8	-	-	-	71	68
9	-	-	-	9	12

Discussion

In a study done by Cave[2] on 153 clavicles of Europeans, it was found that the flat and rough (type 1) rhomboid impression was the commonest type, which was observed in 20% of right sided clavicles and 38.8% of left sided clavicles. This was followed by the flat and smooth rhomboid impression, which was observed in 29% cases[2]. Similar results were obtained by Balvir *et al.*[12], in which flat and rough (type I) was present in 63.33% of the total cases. Rani *et al.*[13] studied 118 Indian clavicles, found that depressed and rough pattern (30.97%) of rhomboid impression was highest. The depressed and smooth type (1.77%) being the least[13]. Rogers *et al.*[4] described them as deep fossa. tubercle, shallow groove and no impression, but the various patterns were not described. But the present study differed from the above, and showed that elevated and rough (type IIA) was the commonest type of pattern of rhomboid ligament. This was present in 32.5% of specimens followed by depressed and rough type (type III A), which was found in 27.5% of specimens. Elevated and smooth, depressed and smooth patterns of rhomboid impression were not observed in the present study. The observations of the present study were compared with the previous reports and represented in table 4.

Table 4. Comparison between studies on types of rhomboid impression.

Rhomboid impression (types)	Cave2 (n=153)		Balvir *et al.*12 (n=60)		Present study (n=80)	
	Right clavicle	Left clavicle	Right clavicle	Left clavicle	Right clavicle	Left clavicle
Flat & rough	20	28	18	20	11	7
Flat & smooth	21	21	14	18	4	10
Depressed & rough	15	12	9	9	12	10
Depressed & smooth	13	3	5	5	-	-
Elevated & rough	5	8	7	7	13	13
Elevated & smooth	4	0	1	1	-	-

The rough attachment of costo-clavicular ligament suggests the absence of an intervening bursa and its direct attachment to the clavicle. The smooth morphology indicates the presence of intervening bursa between the anterior and posterior laminae as described by other authors[1,2]. Carrera[14] and Bisson *et al.*[3] have suggested the importance of rhomboid ligament in the resection of medial end of clavicle. The average distance between the medial end of clavicle and medial most point of attachment of costo-clavicular ligament was 8.33 mm. Hence a resection length of 8 mm on the medial side of clavicle is safe without much of damage to the rhomboid ligament. This was similar to the study done by Bisson *et al.*[3] on 86 cadavers, who showed that resection of 1.0 cm of medial clavicle is safe in 84% of men and resection of 0.9 cm is safe in 89% of women without much disruption of costoclavicular ligament.

The present study showed that the medial one third of clavicle shows a transition from quadrangular to prismoid shape, implying the tubular form. The middle third shows a transition from circular to transverse oval, implying flattening in superoinferior plane.

The lateral one third was almost flattened oval. This was similar to the study done by Walter[15] on 100 dry clavicles by dividing the shaft to various regions based on muscular and ligamentous attachment.

Conclusion

The findings of this study will help the orthopaedicians in understanding the fractures and planning the adequate fixative devices. The medial and middle one third parts of clavicle, being more tubular in morphology are suitable for the placement of fixative device. The lateral one third of clavicle is flattened supero-inferiorly, which restricts the placement of fixative devices.

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